



07/19/00

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July 19, 2000

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**Box: PATENT APPLICATION**

Commissioner for Patents  
 Washington, D.C. 20231

Attorney Reference: LIE 105

**Re:** New Patent Application of: LIANG, et al.  
**Title:** APPARATUS FOR LOADING/UNLOADING WAFERS TO AND FROM  
 SEMICONDUCTOR FABRICATION EQUIPMENT

Sir:

Please find attached hereto an application for patent which includes:

- [x] Specification, Claims and Abstract (10 pages)
- [x] 9 Sheets of Formal Drawings (Fig. 1 through Fig.9)
- [x] Inventor's Declaration and Power of Attorney (2 Pages)
- [ ] Claim for priority and Priority document
- [x] Assignment document with cover page (4 Pages)
- [x] Fee (see formula below)
- [ ] Disclosure of Related Application
- [ ] Small entity form ( Page)

Basic Fee \$345/690 \$ 690.00

Additional Fees:

Total number of claims: 9 \$ 0.00  
 in excess of 20: 0 times \$9/18

Number of independent claims: 1 \$ 0.00  
 in excess of 3: 0 times \$39/78

Multiple Dependent Claims \$130/260 \$ 0.00

Recording Fee \$40. \$ 40.00

**TOTAL FEES FOR THE ABOVE APPLICATION** \$ 730.00

In the event there is attached hereto no check, or a check for an insufficient amount,  
 please charge the fee to our Account No. 18-0002 and notify us accordingly.

Respectfully submitted,

**23995**

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PATENT TRADEMARK OFFICE

FEE ENCLOSED:\$ 730  
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July 19, 2000  
 Date

**APPARATUS FOR LOADING/UNLOADING WAFERS TO AND FROM**  
**SEMICONDUCTOR FABRICATION EQUIPMENT**

**Field of the invention**

The present invention relates to an apparatus for loading and unloading  
5 wafers to and from the fabrication equipment and, more particularly, to an  
apparatus conforming to the specification of SMIF (standard mechanical  
interface) E19.4 200 mm standards. The present invention is compatible with  
existent openers of IC factories, and can integrate the wafer pod into the  
fabrication equipment to form an automated wafer separating and fabricating  
10 apparatus.

**Background of the invention**

The purpose of a SMIF system is to isolate the semiconductor fabrication  
equipment and wafers in a clean environment of class 1, while the handler  
working in a clean environment of class 100. The SMIF system can effectively  
15 reduce the maintenance cost of the IC factory, increase the yield of products,  
and provide a comfortable working environment for the handler. The SMIF  
opener is an apparatus for loading/unloading wafers to and from the  
semiconductor fabrication equipment. Its primary function is to remove a wafer  
cassette out from a wafer pod. A robot then grabs a single wafer into the  
20 fabrication equipment to proceed the fabrication process. The SMIF opener can  
easily integrate the wafer pod into the fabrication equipment to form an  
automated wafer separating and fabricating apparatus.

As shown in Figs. 1 and 2, because an opener 1a in prior art uses three  
square screws 10a for driving and a universal shaft bearing as a lead device  
25 (not shown), the assembling with components of the main body such as a port

plate 11a, a port plate supporter 12a, a port door (not shown), and a base 13a does not have a reasonable and modular design. Under the situation that there are many associated components, it is difficult to control the assembling accuracy of components of the main body responsible for the upward and

5 downward movement of the opener. The whole structural rigidity is also not high enough. Moreover, under the situations that the pitch error of the three square screws is large and that the synchronism of their movement is bad, the accuracy of positioning transfer of wafers and the lifetime of the equipment will be deteriorated. The assembling of the opener will also be more difficult.

10 In addition, because the assembling of the main body does not adopt a modular design, the structure of the pod hold-down latch mechanism module and the pod unlock mechanism module, both using the same drive source, will be complicated so that the assembling/disassembling and maintenance are difficult. Moreover, the number of components compatible with wafer pods of different

15 sizes will be decreased.

### **Summary and objects of the present invention**

The primary object of the present invention is to provide an opener. The present invention uses two U-shaped port plate supporters of high rigidity to respectively join with drive devices such as lead screws, shaft bearings, and a

20 lead device, and then join with components such as a port plate, a port door, and a base. The assembly is driven by a motor via timing pulleys, timing belts, idle wheels, a pair of lead screws, shaft bearings, and a lead device. An encoder is matched for feedback control. Thereby, accurate positioning of the main mechanism of the wafer pod responsible for upward and downward movement

25 can be achieved so as to increase the accuracy and reliability of positioning

transfer of wafers. Secondarily, the contamination of particles resulted from the motion of the main mechanism can be reduced by using an intake filtering system. Because the present invention adopts a modular design, the drive source of each unit is isolated and the circuit of each unit is hidden so that the  
5 whole structure is most compact and the assembling/disassembling and maintenance are easier.

The various objects and advantages of the present invention will be more readily understood from the following detailed description when read in conjunction with the appended drawings, in which:

10 **Brief description of drawing:**

Fig. 1 is a cross-sectional bottom view of an opener in prior art;

Fig. 2 is a side view of an opener in prior art;

Fig. 3 is a perspective view of the present invention;

Fig. 4 is an exploded perspective view of the present invention;

15 Fig. 5 is a perspective view of the present invention with the protective cover of the port plate supporter removed;

Fig. 6 is a top view of the present invention with the port plate removed;

Fig. 7 is a bottom view of the present invention;

Fig. 8 is a cross-sectional side view of the pod hold-down latch mechanism  
20 module of the present invention;

Fig. 9 is a cross-sectional top view of the pod hold-down latch mechanism module of the present invention.

**Detailed description of preferred embodiment**

As shown in Figs. 3 to 6, the present invention provides an opener. The  
25 opener 1 generally comprises a main assembly 10, a pod hold-down latch

mechanism module 11, a pod unlock mechanism module 12, a wafer reseat mechanism module 13, and an electrically controlled communication module (not shown). The present invention aims to improve the lifting/lowering mechanism of the main assembly 19.

5       The main assembly 10 is the main mechanical structure comprising a port plate 14, two port plate supporter 15, a port door 16, and a base 17. The port plate 14 is used to load the wafer pod and is matched with components and circuits (not shown) for scanning wafers. The pod hold-down latch mechanism module 11 and the pod unlock mechanism module 12 are also installed therein.

10      The port plate supporters 15 form the upward/downward passage of the opener and are composed of U-shaped plates of high rigidity. Two lead screws 18 and two lead poles 19 needed for the upward/downward movement of the port door 16 are installed on the port plate supporters 15. The top ends of the port plate supporters 15 are connected to the port plate 14 and the bottom ends of the port

15      plate supporter 15 are connected to the base 17. The two port plate supporter 15 can be sheathed in protective covers 31. The port door 16 is a support platform of the pod door with the pod unlock mechanism module 12 installed thereon. The port door 16 is used to unlock the wafer pod and move the wafer cassette upwards or downwards. Two opposite sides of the port door 16 are secured to

20      two drive plates 33 via screws 32. A screw nut 34 is installed on each of the two drive plates 33. The screw nuts 34 are screwed on the lead screws 18. Two shaft bearings 35 are installed on one of the two drive plates 33. The two shaft bearings 35 are slidably matched on the two lead poles 19 to form a lead device. Spring grommets 41 and 42 are installed at the top and bottom ends of the lead

25      screw 18 at the unguided side. The spring grommets 41 and 42 are arranged

between the top and bottom ends of the lead screw 18, the port plate 14, and the base 17 so that the top and the bottom of the lead screw 18 can slightly float to absorb the pitch error. The base 17 is the seat of the opener. The opener is fixed on the fabrication equipment via three positioning holes 20. A drive mechanism 5 21 (shown in Fig. 7) for lifting/lowering the pod door, a motor controller, and a main circuit board of an I/O controller (not shown) are installed in the base 17. The lifting/lowering drive mechanism 21 is in charge of the transfer and positioning of wafers, and comprises a DC servo motor 22, a plurality of timing pulleys 23 to 26, timing belts 27 and 28, and idle wheels 29 and 30. The timing 10 pulley 23 is fixed at the axis of the motor 22, while the timing pulleys 24 to 26 and idle wheels 29 and 30 are supported on the bottom of the base 17. The timing pulley 23 is connected to the timing pulley 24 via the timing belt 27. The timing pulley 24 is then connected to the timing pulleys 25 and 26 via the timing belt 28. The two timing pulleys 25 and 26 are fixed at the bottom ends 15 of the lead screws 18. The idle wheels 29 and 30 sticks to the timing pulley 26. The lifting/lowering drive mechanism 21 can drive the lead screws 18 via the timing pulleys 23 to 26 and the timing belts 27 and 28 to move the pod door upwards or downwards through the power generated by the motor 22. An encoder can also be matched for feedback control so that the main mechanism 20 responsible for the upward/downward movement of the opener can be accurately positioned.

The pod hold-down latch mechanism module 11 is used to secure the pod top of the wafer pod to prevent the pod top from detaching from the port plate 14. Retaining sheets 37 are respectively driven by left and right DC motors 36 25 (shown in Figs. 8 and 9) to maintain the compactness and stability of the

mechanism. The pod unlock mechanism module 12 situated below the port door 16 is used to control the fastening and unfastening of the internal mechanism of the pod door to facilitate the separation of the pod top and the pod door. The wafer reseat mechanism module 13 can be driven by a sensor to  
5 automatically move protrudent wafers into the wafer cassette to prevent the wafers from being damaged during the sealing process of the pod top and the pod door.

In addition, the present invention has an intake filtering system 38 comprising a filter 39 and a plurality of intake pipes 40. The filter 39 is  
10 installed on the base 17. The intake pipes 40 are installed at the openings of the protective covers 31 to form air shield so as to prevent particles from going out to contaminate wafers. The contamination of particles generated by the motion of the mechanism can be reduced by using the intake filtering system 38.

As compared to the Asyst Indexer, the present invention has the following  
15 advantages:

1. Interface size: The present invention conforms to the specification of the SMIF E19.4 200 mm standards and is compatible with the Asyst Indexer;
2. Port plate supporter: The present invention uses a pair of U-shaped port plate supporters of high rigidity, which can be joined with the drive device  
20 such as the lead screws, the shaft bearings, and the lead device independently;
3. Drive system: The drive mechanisms of the present invention adopt independent and modular designs. The pod hold-down latch mechanism module is simple. The accuracy of the lifting/lowering mechanism of the main assembly can also be controlled easily. Moreover, the assembling  
25

and testing of the whole mechanism is convenient so that the maintenance and replacement is easy.

4. Quantity of lead screws: The present invention uses two lead screws. The quantity of the lead screws is less so as to simplify the drive mechanism.

5 Moreover, the top and bottom of the lead screw at the unguided side can slightly float to absorb the pitch error to facilitate synchronous control.

5. Lead device: The present invention uses two lead poles situated at the same side to provide better guidance. Therefore, the accuracy can be controlled easily, and the assembling is convenient.

10 6. Intake filtering system: the filtering system of the present invention is of long groove-opening limiting type. Air shield can be formed at the openings of the protective covers to prevent particles from going out to contaminate wafers. Particles generated by the moving mechanisms can also be effectively removed.

15 Although the present invention has been described with reference to the preferred embodiments thereof, it will be understood that the invention is not limited to the details thereof. Various substitutions and modifications have suggested in the foregoing description, and other will occur to those of ordinary skill in the art. Therefore, all such substitutions and modifications are intended  
20 to be embraced within the scope of the invention as defined in the appended claims.

**I claim:**

1. An apparatus for loading and unloading wafers to and from the fabrication equipment, especially an apparatus with an improved main assembly, said main assembly comprising:
  - 5      a port plate;
  - a base;
  - two port plate supporters with two lead screws and a lead device installed thereon, the top ends of said two port plate supporters being connected to said port plate, the bottom ends of said two port plate supporters being connected to said base;
  - 10     a port door with two screw nuts installed at opposite sides thereof, said port door being screwed to said two lead screws via said two screw nuts;
  - a lifting/lowering drive mechanism installed on said base, said lifting/lowering drive mechanism comprising a motor, timing pulleys, and timing belts, said lifting/lowering drive mechanism can drive said lead screws to move said port door upwards or downwards via said timing pulleys and timing belts through the power generated by said motor.
2. The apparatus for loading and unloading wafers of claim 1, wherein a pod hold-down latch mechanism module and a wafer reseat mechanism module  
20      are installed on said port plate.
3. The apparatus for loading and unloading wafers of claim 1, wherein said two port plate supporters are sheathed in protective covers, and an intake filtering system comprising a filter and a plurality of intake pipes having long groove-openings is also installed, said intake pipes being installed at the openings of said protective covers to form air shield to prevent particles from  
25

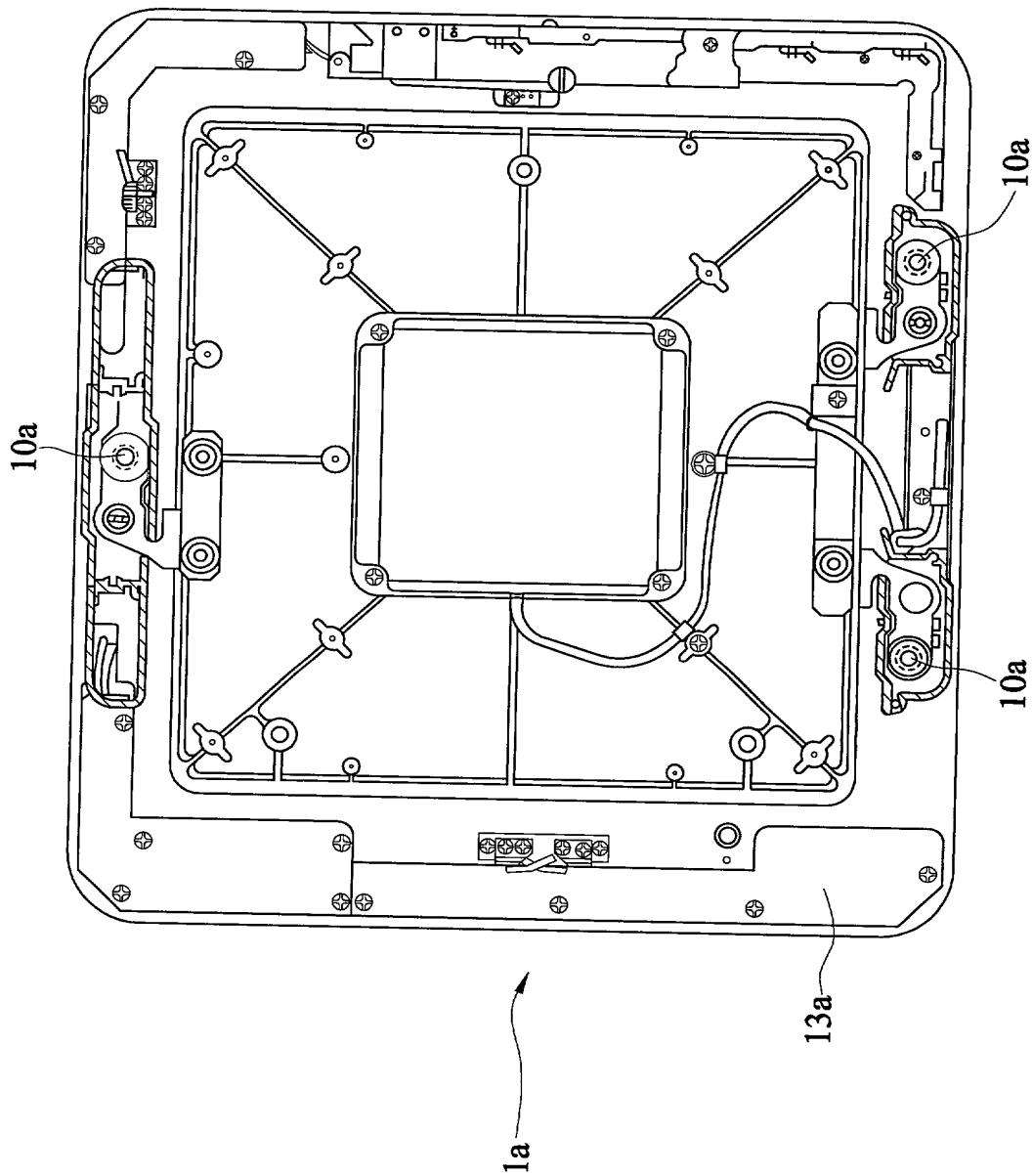
going out to contaminate wafers.

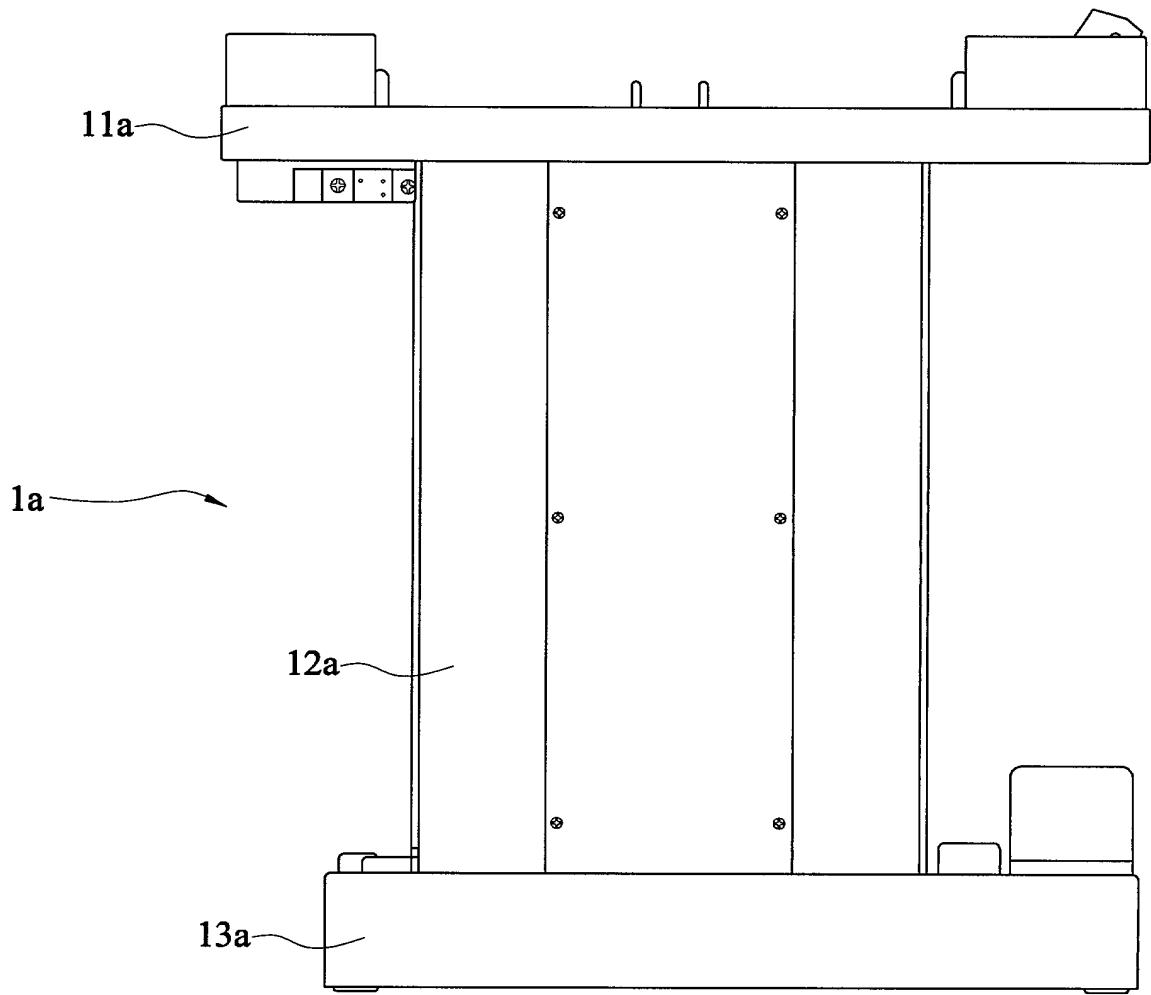
4. The apparatus for loading and unloading wafers of claim 1, wherein said port plate supporters are made of U-shaped plates of high rigidity.
5. The apparatus for loading and unloading wafers of claim 1, wherein a pod unlock mechanism module is installed on said port door.
6. The apparatus for loading and unloading wafers of claim 1, wherein two opposite sides of said port door are secured to two drive plates, each of said two drive plates having a screw nut thereon to be screwed to said lead screw via said screw nut, two shaft bearings being installed on one of said two drive plates, said two shaft bearings being slidably matched on two lead poles to form said lead device.  
10
7. The apparatus for loading and unloading wafers of claim 1, wherein spring grommets are installed at the top and bottom ends of said lead screw at the unguided side, said spring grommets being arranged between the top and bottom ends of said lead screw, said port plate, and said base so that the top and bottom of said lead screw can float to absorb the pitch error.  
15
8. The apparatus for loading and unloading wafers of claim 1, wherein said base has a plurality of positioning holes disposed thereon to be fixed on the fabrication equipment.
- 20 9. The apparatus for loading and unloading wafers of claim 1, wherein said lifting/lowering drive mechanism also has idle wheels sticking to said timing pulleys.

## **Abstract**

The present invention proposes an apparatus for loading and unloading wafers to and from the semiconductor fabrication equipment. The present invention uses two U-shaped port plate supporters of high rigidity to 5 respectively join with drive devices such as lead screws, shaft bearings, and a lead device, and then join with components such as a port plate, a port door, and a base. The assembly is driven by a motor via timing pulleys, timing belts, idle wheels, a pair of lead screws, shaft bearings, and a lead device. An encoder is matched for feedback control. Thereby, accurate positioning of the main 10 mechanism of the wafer pod responsible for upward and downward movement can be achieved so as to increase the accuracy and reliability of positioning transfer of wafers. Secondarily, the contamination of particles resulted from the motion of the main mechanism can be reduced by using an intake filtering system. Because the present invention adopts a modular design, the drive 15 source of each unit is isolated and the circuit of each unit is hidden so that the whole structure is most compact and the assembling/disassembling and maintenance are easier.

FIG.1  
PRIOR ART





**FIG.2**  
**PRIOR ART**

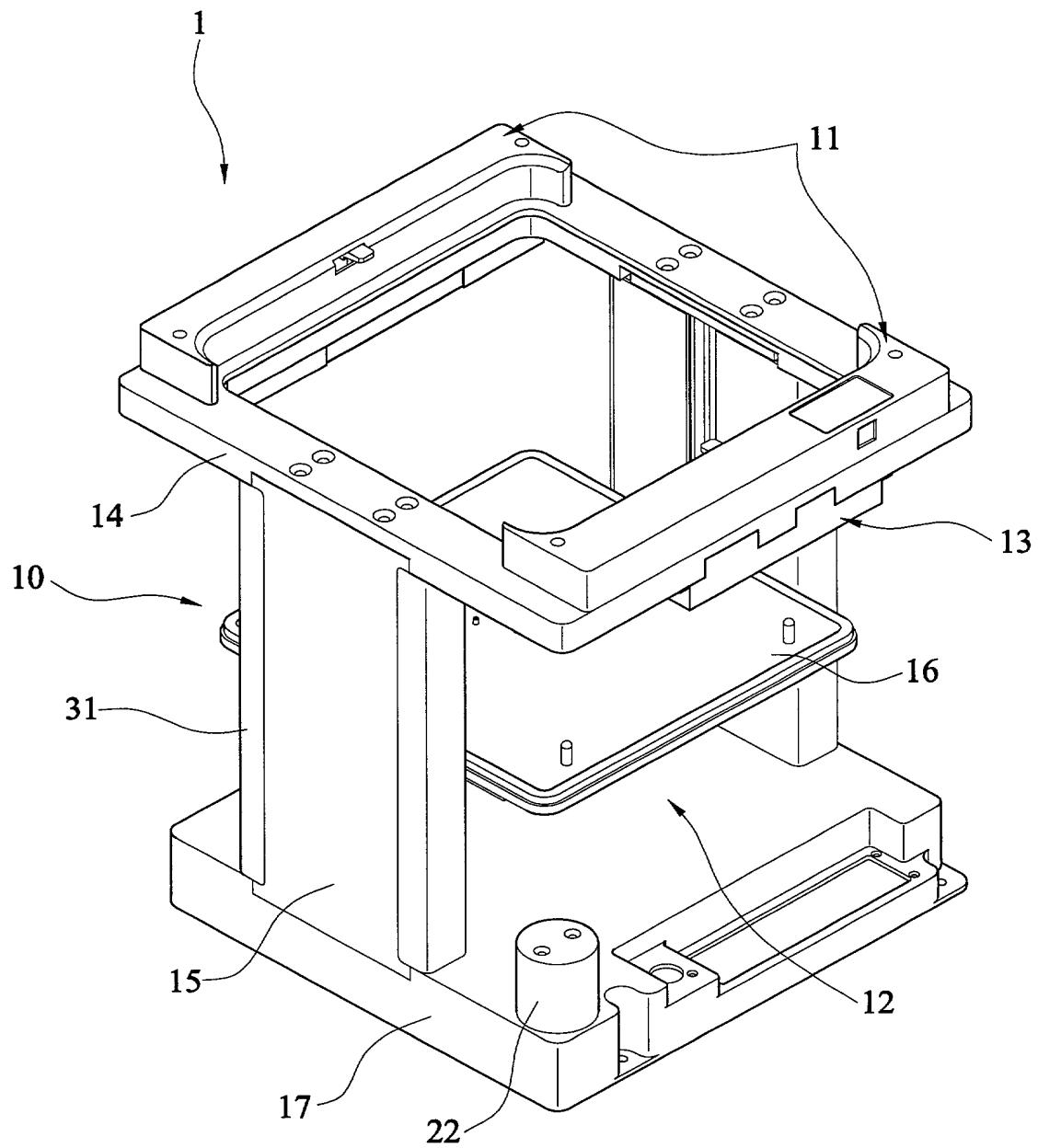
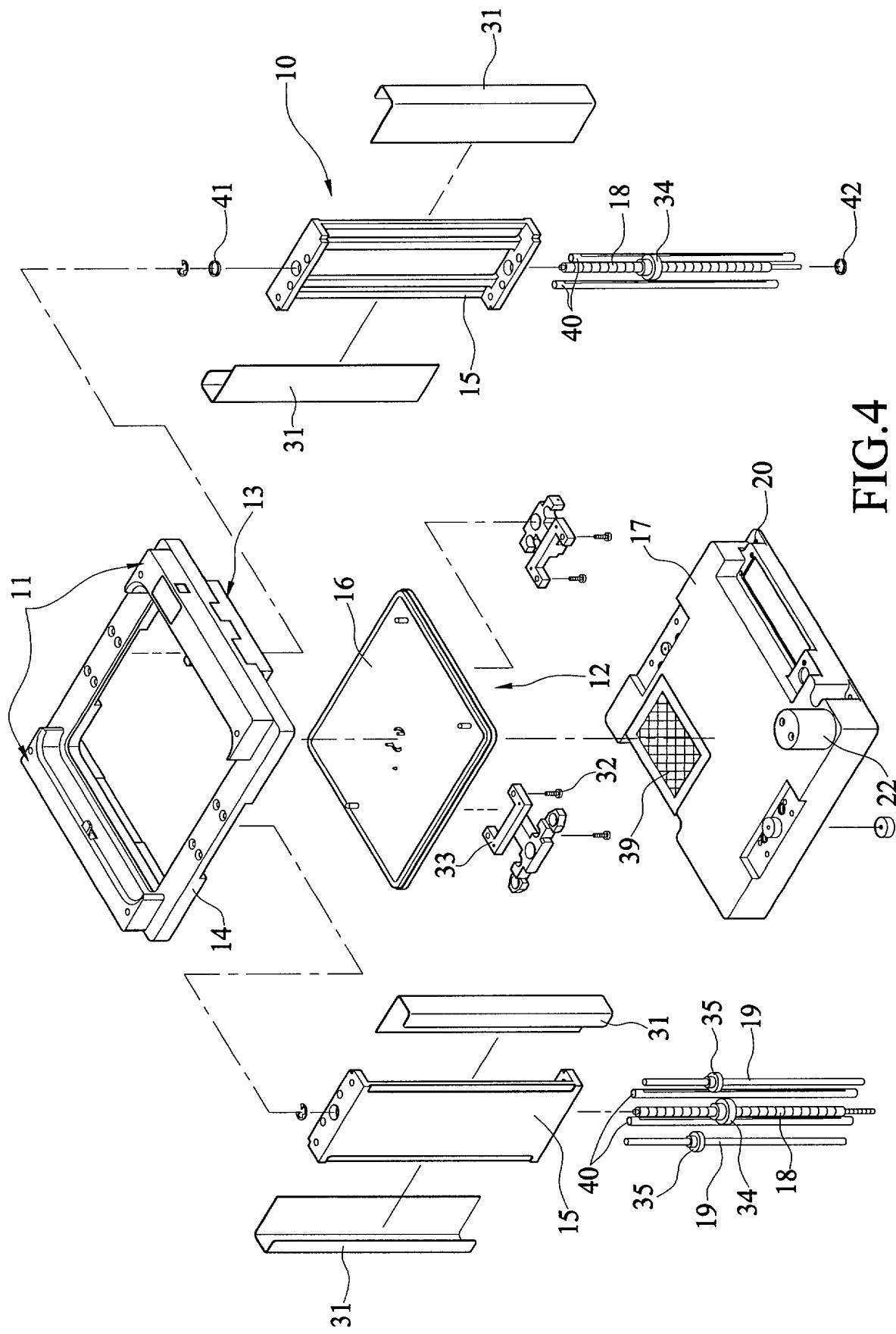


FIG.3

FIG.4



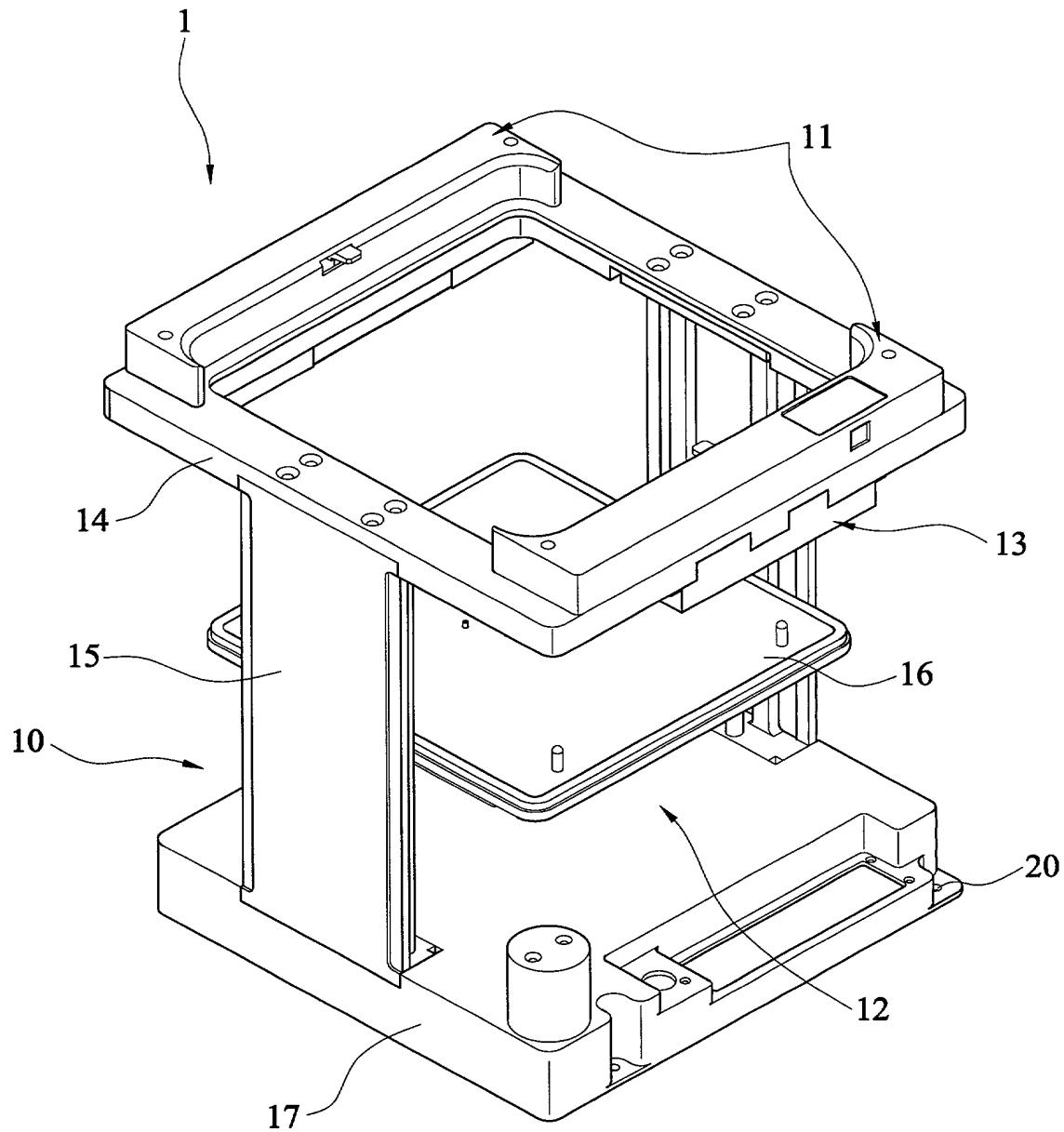
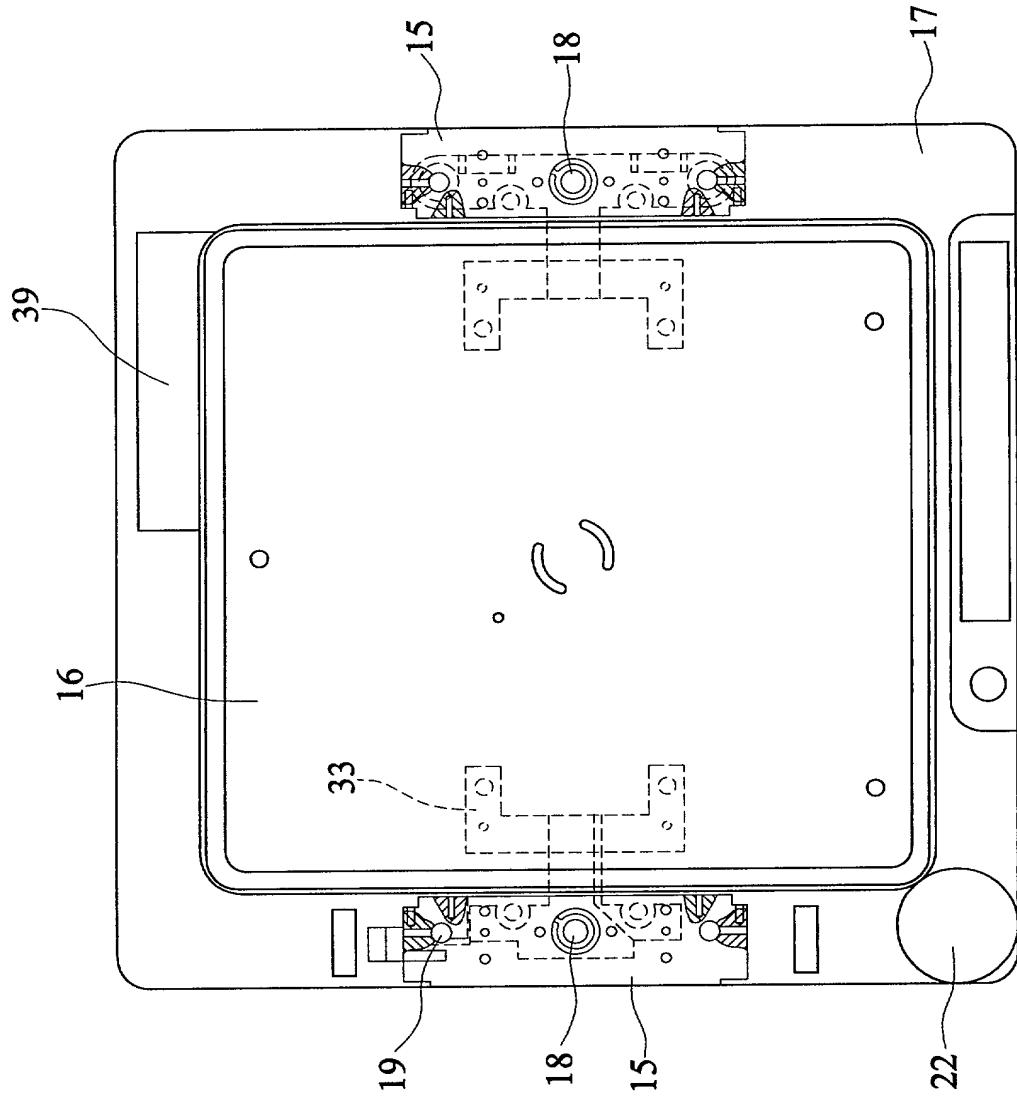


FIG.5

FIG.6



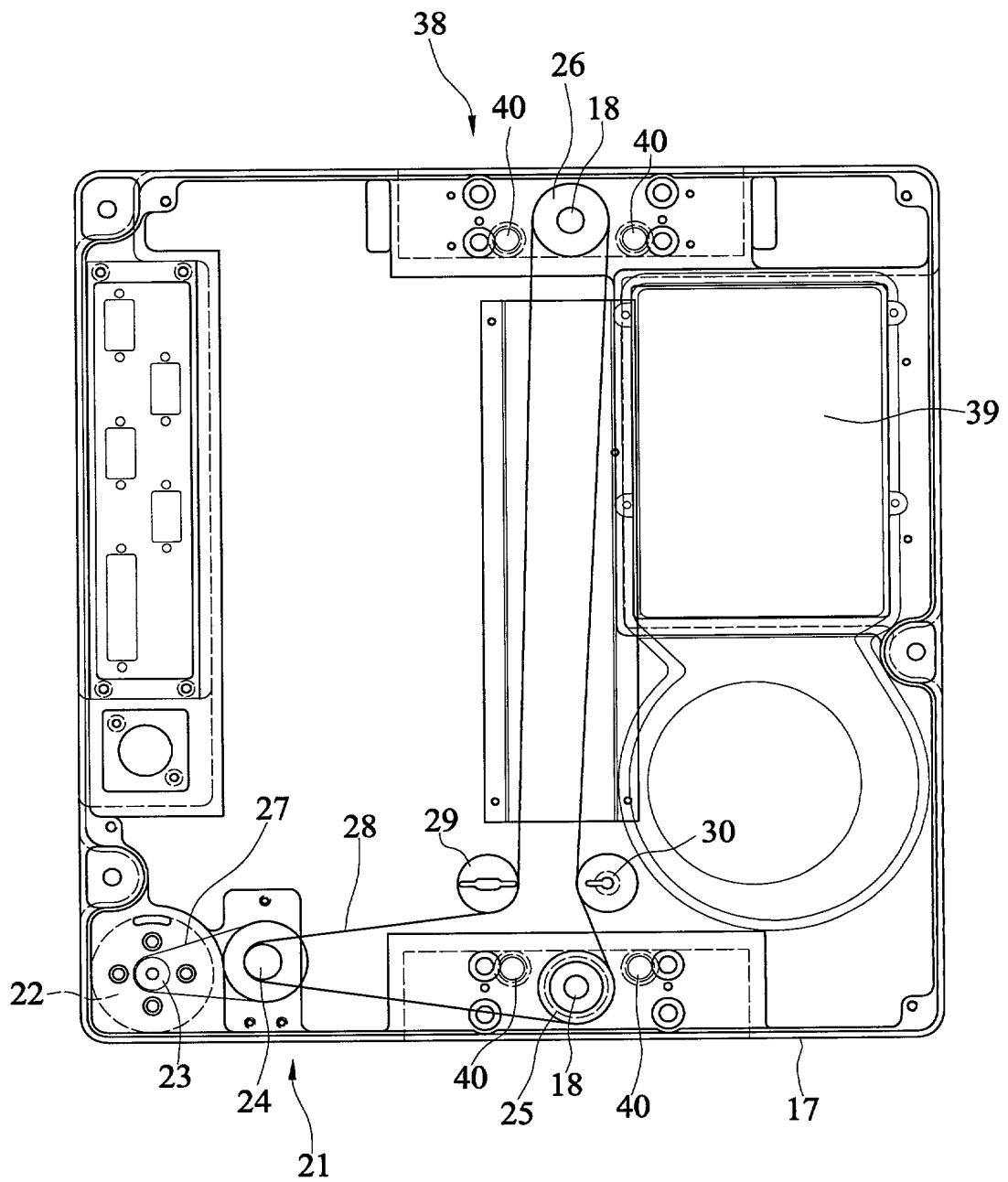


FIG. 7

**FIG. 8**

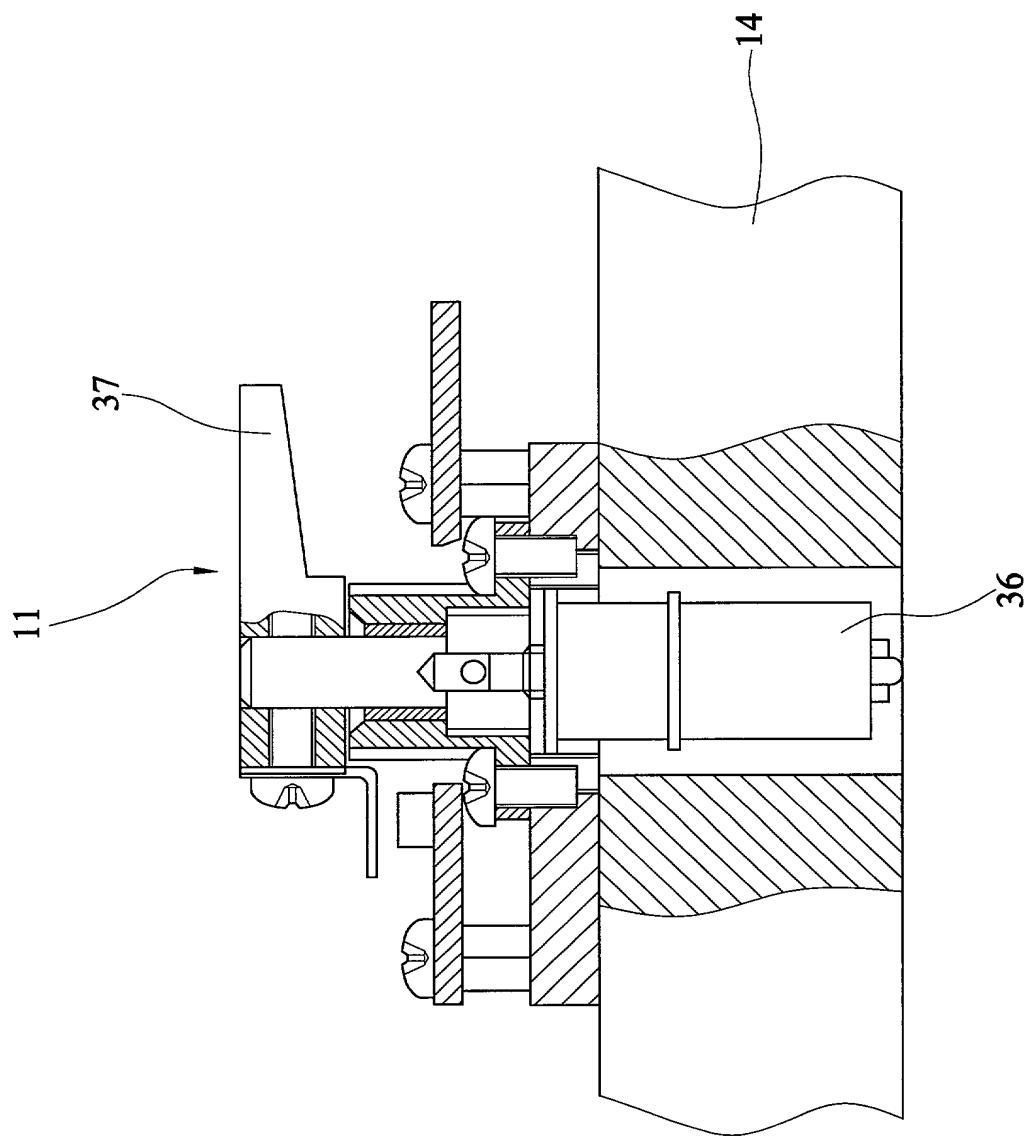
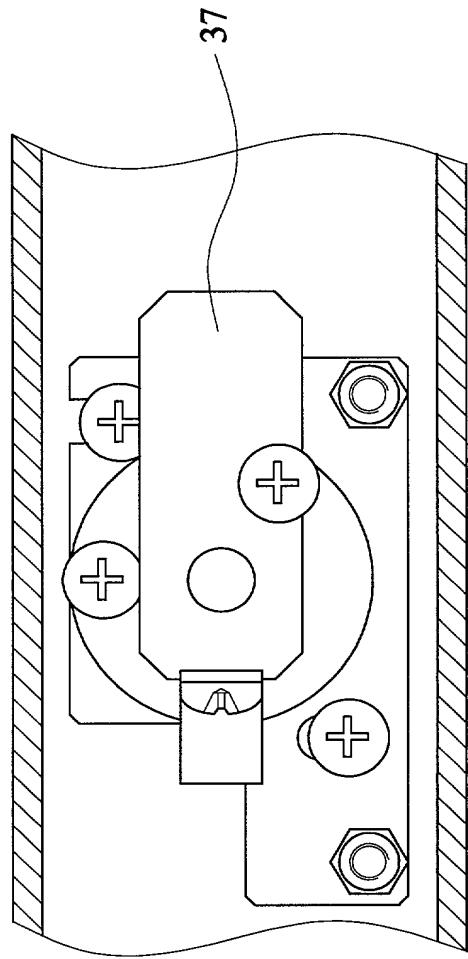


FIG.9



**DECLARATION FOR UNITED STATES PATENT APPLICATION,  
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS**

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and that I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Apparatus for loading/unloading wafers to and from semiconductor fabrication equipment  
the specification of which

[X] is attached hereto.

[ ] was filed on \_\_\_\_\_, as Application Serial No. \_\_\_\_\_  
and was amended on \_\_\_\_\_ [if applicable].

[ ] was filed under the Patent Cooperation Treaty on \_\_\_\_\_  
Serial No. \_\_\_\_\_, the United States of America being designated.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose to the Patent and Trademark Office information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s) Number	Country	Date Filed	Priority Claimed Yes      No

I hereby appoint the following attorneys to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith: Steven M. Rabin (Reg. No. 29,102), Thomas M. Champagne (Reg. No. 36,478), Robert H. Berdo, Jr (Reg. No. 38,075), and Charles W. Peterson, Jr (Reg. No. 34,406), 1725 K Street, N.W., Washington, D.C. 20006, Telephone: (202) 659-1915; Fax: (202) 659-1898. Address all correspondence to RABIN & CHAMPAGNE, P.C., 1725 K Street, N.W., Suite 1111, Washington, D.C. 20006.

The undersigned hereby authorizes the U.S. attorneys named herein to accept and follow instructions from the undersigned's assignee, if any, and/or, if the undersigned is not a resident of the United States, the undersigned's domestic attorney, patent attorney, patent agent, or patent representative as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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DECLARATION FOR UNITED STATES PATENT APPLICATION,  
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS

Page 2 of 2

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